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THE ALLOCATION OF RESOURCES TO LIVESTOCK RESEARCH IN AFRICA

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Introduction

1. This paper looks at the allocation of resources to livestock research in Africa. It starts by assessing the role of agricultural research and its value to national governments before turning to the particular problems faced by decision-makers in ensuring an optimal allocation of resources between alternative research activities. The appropriate criteria to use for decision-making are investigated by comparing three kinds of decision-making models. The paper then goes on to see how people have tried to explain the actual direction taken by agricultural research in different countries, illustrating alternative theories by the use of case studies. Finally, the paper presents a number of conclusions for policy-making which arise from the previous discussion.

The Role of Agricultural Research

2. The aim of research is to raise the productivity of existing resources by evolving improved methods of production and by the introduction of new inputs. During the twentieth century, many developed countries have seen large increases in agricultural output and farmer incomes, most of which can be attributed to the application of research-based technologies. A number of studies have tried to calculate the returns to investment in agricultural research. In almost all cases, these calculations produce very high rates of return to the investment; for example, Boyce and Evenson (1975) list eleven studies which show rates varying from 21% to 93%. While certain assumptions behind these rate of return calculations are open to question, such high figures do indicate that more resources could profitably be invested in agricultural research, since few projects in other sectors can return rates over 20%.

3. Governments have usually been involved in much agricultural research because few, if any, farmers could individually finance a research programme of any depth. In addition, since agricultural research results are rarely appropriable, private investors are not likely to invest sufficiently in this field. The case, therefore, for expenditure by governments on research is strong; research can generate high returns for the economy as a whole, but the private sector will not assure an optimum level of investment in this activity. Governments must decide firstly, what level of resources

to allocate to research as a whole and secondly, how to distribute the research funds between competing demands. This paper is concerned with the latter question. Ideally, the government wants to maximise the benefit to be derived from each dollar spent on research in any one field and to ensure sufficient coverage of different areas in order that those with high potential are not neglected. However, as will be seen below, there are certain characteristics of the research process which present the decision makers with particular problems in approaching the optimal allocation of resources and in gaining the maximum benefit from expenditure on research.

Resource Allocation to Research

4. All decision makers have to work within a world where resources are scarce in comparison with alternative areas for their use. Those responsible for the allocation of funds to competing lines of research are no exception to this rule of constrained decision making, and certain characteristics of research make it particularly difficult to decide on the best distribution of resources.

5. The first of these characteristics is that the net benefit from any line of research is, by its very nature, uncertain, since there is no sure way of predicting whether a particular group of researchers will be able to develop a technology of significant value to producers. Success will depend both on the ability of the research personnel in raising resource productivity and the mix of factor and product prices which will enable producers to profit from such improvements in technology. Livestock production presents an area of research where uncertainty is compounded by the long time-horizon over which research must be done. Cattle, for example, take several years to achieve maturity and have a long gestation period, which slows the rate at which genetic research work can be done. Similarly, the productivity of semi-arid rangelands exhibits marked fluctuations, due to the complex interaction of a number of factors - rainfall distribution, stocking rates, species composition, soils, etc. - which can only be unravelled by observations over a period of many years. Even when a new technology has been developed, its successful adoption by farmers is not assured, since this will depend crucially on the structure of input and output prices and on the adequacy of the extension system through which the supply of essential

inputs can reach the producer.

6. The second problem which arises in comparing alternative research projects is how to value changes in welfare resulting from the introduction of new techniques of production. For example, the introduction of high-yielding cereal varieties and mechanisation have had complex effects on the distribution of incomes and on relative prices in the rural and urban areas of several South Asian countries. Increased output and lower prices of food grains have benefitted the rural poor and urban consumers, raising their welfare. Mechanisation has reduced demand for labour at certain times of the year yet has raised it at others for operations which can be less easily done by machine. This has caused a shift in the incomes of hired labourers and the wage-bill of farmers taking on labour, with resultant changes in each group's welfare. It may be unclear beforehand exactly how prices and wages will change as a result of introducing a new technology. But some likely changes can be predicted and decision makers should take these into account in deciding what kind of research to promote.

Appropriate Criteria and Decision-Making Models

7. The previous section outlined the two main problems which face decision makers in deciding how to allocate resources between alternative lines of research, namely uncertainty as to whether any particular research project will produce profitable new technologies and the difficulty in valuing changes in welfare resulting from the introduction of new techniques of production. Several models have been developed by economists to help clarify the decision making process by allowing the comparison of the consequences of alternative funding patterns. Three of these models are presented below. The choice of any one of these will depend on the nature of the data and the amount of time available to decision makers.

   (i) Rules of Thumb: The simplest way to approach the problem of resource allocation is to decide on one criterion by which to judge alternative strategies. A common rule of thumb would be to base the decision of what sum to allocate to each line of livestock research according to the importance of that livestock species in total animal production. Where, for example, total livestock output is accounted for by cattle worth $50m, sheep worth $20m and camels worth $10m, then it might

appear reasonable to allocate research resources in the proportions of 5:2:1, to cattle : sheep : camels respectively. However, suppose that cattle production was restricted to high rainfall areas that made up only 25% of the country's land area while sheep and camel production occupied the remaining 75% of the land area. Decision makers could then argue with some justice that research into camel and sheep production deserved a larger share of the budget than that indicated by the relative size of their current output. Conversely, if cattle alone are exported, the case could be made that this species should receive all research resources where increased export earnings are a government priority. Conflicting criteria produce widely differing advice for the allocation of resources between competing uses and rules of thumb cannot deal with such a situation. To overcome this, a decision-making model should be able to take several objectives into account, giving each objective a certain weight, according to its importance within the priorities of the government or research organisation. Scoring models, described in the next section, attempt to provide such a model and are thus superior to simple rules of thumb.

(ii) Scoring Models: These models provide for more complex decision-making situations by laying down a small number of objectives, each of which is given a weight according to the priority attached to it. Thus, for example, research on cattle in country A could have the following objectives and weights attached:

Objectives	Weights
(a) Growth in productivity	3
(b) Reduction in variability of producers' income	2
(c) Distribution of welfare gains to the poorest 25% of the population	4
(d) Increase in export earnings	5

These objectives are not necessarily either independent or mutually compatible; for example, research aimed at expanding exports of beef could well stress management levels that had little relevance for the poorest section of the population. Choice of weights is a political question and it is the responsibility of national governments to decide the value placed on contributions made to different aims.

The next step with a scoring model is for researchers to assess how far each possible research project is likely to contribute towards the objectives laid down earlier. A scale is adopted to rate the size of the estimated effect which a project will have on each objective, an example of which is shown below:

Effect of Objective	Scale
Large and positive effect	+ 2
Small and positive effect	+ 1
No effect at all	0
Small and harmful effect	- 1
Large and harmful effect	- 2

The likely effect of a research project can then be reduced to a single aggregate figure composed of the sum of each objective's weight multiplied by the scale of the estimated effect on this objective by the research project. Projects can then be compared and those with the highest scores chosen for funding. An example of such a comparison of alternative projects is shown below.

Project One - A research project to establish cross-breeding trials to produce a fast-growing beef animal scores the following:

Objective	Estimated effect	Weight	Product
(a)	Large, positive (+2)	3	+ 6
(b)	No effect (0)	2	0
(c)	No effect (0)	4	0
(d)	Large, positive (+2)	5	+ 10

This gives a total of + 6 + 10 equalling 16 points.

Project Two - A project aimed at doing research into improving the utilisation of crop residues for dairy cow nutrition scores the following:

Objective	Estimated effect	Weight	Product
(a)	Small, positive (+1)	3	+ 3
(b)	Large, positive (+2)	2	+ 4
(c)	Small, positive (+1)	4	+ 4
(d)	No effect (0)	5	0

This gives a total of + 3 + 4 + 4 equalling 11 points.

If insufficient funds existed to finance both projects, then with the above weights and assessments of each project in contributing to

objectives (a) to (d), Project One should be chosen.

However, two difficulties arise with the use of this method; firstly the largely subjective assessment researchers must make of the likelihood of a particular project contributing to a given objective and secondly, the formulation of weights to attach to each objective. Nevertheless, scoring models have the advantage of encouraging a clearer formulation of research policy objectives and of making researchers consider more explicitly the likely impact of alternative activities on government priorities.

(iii) Cost-Benefit Models: These models require that an estimate is made of research costs over the length of a project and of the probable distribution of benefits over time. In most cases, a discount rate is used to attribute lesser value of costs and benefits which occur in the distant as opposed to the near future. The cost and benefit streams are compared and depending on their relative size, a project is either accepted or rejected. This decision making model is derived from the familiar techniques of project appraisal using cost-benefit analysis. However, calculation of the flow of costs and benefits expected to flow from a research project is not an easy exercise. While the cost flow may be relatively easy to calculate, estimating the benefits flow involves making a number of assumptions about the success of the research project and the rate of adoption by producers of new technologies developed. Both of these are highly uncertain events, without a known probability distribution attached to each outcome.

8. The above three models illustrate different approaches to decision making, each with its own strengths and weaknesses. Each provides a framework within which alternative uses of resources can be considered so that choices can be made on a clearer basis. The availability of data and of time will determine which model to use; the scoring model represents a reasonable comparison between the need to consider multiple objectives with limitations on the amount of data available. The next section will look at how research resources have actually been allocated in a number of cases and it will be shown that it is rare for the distribution of funds to have been decided on such rational grounds.

How is Research Policy Actually Determined?

9. A number of writers have been interested in assessing the relative importance of different factors in accounting for the direction and content of research programmes in a variety of countries. Three factors emerge which seem to be of importance in explaining the nature of the research process: relative factor prices, the role of powerful interest groups, and the influence of researchers themselves. Each of these factors will be looked at in turn in the light of case study material which is discussed in greater detail by Toulmin (1984).

Relative Factor Prices

10. Writers such as Binswanger and Ruttan (1978), and Hayami and Ruttan (1971) emphasize the role played by relative prices in guiding research resources into their optimal use. They illustrate this by comparing the experiences over the last 50 years of the USA and Japan. The former country exhibits an agricultural sector which is land-abundant and labour-scarce and which has, as a consequence, put much of its research effort into developing machinery to substitute for scarce and expensive labour. By contrast, Japan with its high population density has directed research largely at increasing production by using labour-intensive techniques. The relative prices of land and labour have thus been instrumental in giving each country's research effort a specific objective. Explanations for research orientation in terms of relative factor prices largely abstracts from questions of political power either among producer groups or within the research community.

The Role of Powerful Interest Groups

11. De Janvry (1977), Biggs (1983) and others adopt a more political approach to analysing the direction taken by research and they argue that the main determinant of how research resources are allocated is the relative power of different producing groups. Rich articulate farmers will be much better able to lobby decision makers for support of research programmes from which they will benefit. Poor, small farmers from more marginal areas will be much less well-placed to get decisions made in their favour. Thus, research is likely to be concentrated on solving the problems of the former

groups, solutions which may have little relevance for small producers.

12. A good example of this process by which one particular group of producers can almost completely monopolise the resources of national research institutions is provided by Zimbabwe prior to her independence in 1980. Up to 1980, the aim of the government's livestock research system was stated to be to improve the profitability of commercial beef production. Beef cattle were a major export and it was important to increase earnings from this sector. Thus, most research concentrated on investigating alternative grazing systems, pasture crops and developing optimal feeding regimes to avoid animal weight loss. Dairy cattle and other livestock species received very little attention and little work was done on problems of livestock management in the communal areas. Beef farmers maintained their control over research policy by financial contribution to specifically selected research programmes and by their representation on the board of the Agricultural Research Council which allocates funds to different projects. Other producers, particularly those in the communal areas, lacked the political and economic power to influence the content of research programmes in a way that would have led to work being done on the particular constraints they faced. Until recently, the same pattern of resource allocation towards research benefitting politically powerful farming groups could be seen in Botswana and Kenya; however, more research is now being done in the communal areas of Botswana and the semi-arid rangelands of Kenya, both zones peopled by more marginal livestock producers.

The Influence of the Research Community

13. A third view notes that researchers themselves play a major part in directing research policy. Researchers are not just passive recipients of funds; they compete among themselves for limited resources and influence the way in which funds are allocated to different fields. Schultz (1977) coins the term "research entrepreneur" to describe the role that researchers play in affecting the kind of research that gets funded. The term implies that researchers are comparable with producers of other goods and, to be successful, must know how to package and sell their particular expertise. Researchers achieve their position of power because it is they who inform national or international funders of the importance

or relevance of their particular discipline or approach to problem-solving. Researchers also tend to move into positions of power from which research funds are administered. The dominance of the research community is especially likely where there are limited channels of communication between researchers and the consumers of their research.

14. In many countries in Africa, communication between livestock producers and the research community about the nature of the problems they face is limited for a number of reasons. Research stations are distant and alien institutions for most traditional herders and, while some stations may hold an annual "Open Day" for visitors, most producers will not be in a position to attend. Much of the research carried out on the station may be of little relevance to traditional producers. For example, a lot of time and money has been spent by livestock researchers on the establishment and monitoring of local and cross bred stock under controlled conditions. With a high input of veterinary care and supplementary feeding, major improvements have been achieved in production parameters, such as calf survival rates, age at first calving and milk offtake. In the absence of carefully controlled inputs, however, animal performance suffers a great deal and may fall well below the levels achieved by local stock under unimproved conditions. Few countries have a well-developed system for the provision of inputs and veterinary services; these inputs are also costly. Consequently, few livestock producers are able to take up the more intensive forms of animal production tested and recommended by research stations.

15. The lack of relevance of much research station work can be attributed to three main factors. Firstly, the training of researchers tends to support a "top-down" view of the research process, involving the creation of technologies by the scientific community followed by their transmission to producers for adoption. Little emphasis is given to learning from traditional producers and asking them to define research priorities, a possibly time-consuming business and one which casts the researcher in a "less-than-expert" role. Many research stations are found near large towns, some distance from the zones they are supposed to cover. Researchers expect the comfort of urban life and limit their "excursions" to the field as it lacks electricity and running water. Career structures do not encourage a greater knowledge and involvement with those supposed

to eventually benefit from the research carried out. Secondly, national extension systems rarely operate in the way hoped-for, so that these also fail to act as channels for communication between researchers and consumers of the results of that research. Ideally, extension agents provide such a link as they meet farmers on a regular basis and can discuss the problems they face. Agents then transmit this information to researchers along with their own perceptions of why producers are slow to adopt new technologies and the constraints under which they are operating. In the absence of a viable extension system, researchers can become increasingly isolated from the actual problems and constraints faced by producers. Thirdly, most farmers or livestock keepers lack any form of political organisation or pressure group through which they could find a voice which would allow them some influence in decision making.

16. The independence and isolation of researchers from those supposed to be benefitting from their work has a number of consequences. As noted above, it tends to lead to the pursuit of research projects of limited value to the small-scale traditional producer who has very limited access to modern inputs. It has also led to an inefficient allocation of resources within research systems and the dominance of particular disciplines within the livestock research field because the research community is not accountable to its supposed beneficiaries. Of especial note is the unrivalled position held by veterinary medicine in many national research programmes. This is illustrated by data in Table 1 which shows veterinary work taking roughly two-thirds of livestock research resources in the cases looked at. Several writers have noted over the past few decades that an unjustifiable proportion of resources goes to veterinary medicine and that greater attention should be placed on animal nutrition and management, subjects considered by those writers to be of greater importance to raising livestock productivity. Thus, a report by the Institut de Médecine Veterinaire des Pays Tropicaux (1971) notes that research has been dominated by health matters but that now resources should be shifted towards nutritional questions which constitute at least as great a barrier to improving productivity as does disease. Schwabe (1980) makes a similar point within the Sudanese context when he argues that research should move away from the major livestock diseases such as rinderpest which have become manageable using existing vaccines. Scheper (1978) accounts for the heavy concentration of resources in the field of veterinary medicine

by the controlling position in livestock departments that veterinarians established for themselves during the earlier colonial period. Shaw and Colville (1950) and Ademosun (1976) remark on the same imbalance of resources and manpower within livestock research for the case of Nigeria over a period of twenty five years. Ademosun notes that the National Livestock Committee is staffed by veterinarians and administrators and he recommends that a committee which included those with a background in husbandry, nutrition and range management would ensure a better allocation of research resources.

Table 1. Distribution of Resources Between Different Lines of Livestock Research

Discipline	Country Case Study			
	Kenya 1979/80	Senegal 1974	Nigeria 1977/78	Sudan 1978
Veterinary Research	63%	77%	66%	61%
Animal husbandry & Nutrition	18%	13%	-	17%
Range Research	19%	10%	15%	5%
Processing	-	-	19%	17%
Totals	100%	100%	100%	100%

Sources: Kenya - Wang' ati (1981).
Senegal - Boeckm et al (1974).
Nigeria - Idachaba (1981).
Sudan - FAO (caris) (1978).

17. The direction and content of research programmes has been discussed above, from which it has been seen that there are a number of forces at work which guide research resources into particular channels: (a) the structure of relative prices will make some lines of research particularly attractive, (b) certain powerful interest groups can successfully lobby the research system to provide answers to their most pressing problems, and (c) the research community itself often has an instrumental role in affecting the balance of research programmes, especially where there are few channels through which producers can transmit information to the research system about the constraints under which they operate.

Conclusions for Research Policy

18. Investment in agricultural research is potentially able to provide substantial returns in the form of increased levels of productivity and farmer incomes. This implies that the direction of national research policy should be of major importance to government decision makers. Researchers can be very sensitive to the needs and constraints of producers where regular close contact is maintained between the two groups. Schultz (1977) argues that the history of research demonstrates clearly the vital need for research to be conducted in close relation to the relevant producers, a view supported by many other observers. In certain cases, it has been those producers who wield economic and political power who have been able to monopolise the resources of research organisations along lines of greatest benefit to themselves. The large number of small livestock producers in most countries are unable to exert the same influence, nor can they establish the continuous contact with the research community necessary for it to be responsive to their needs. The limited development of extension systems hinders both the flow of information between research station and traditional producers and it denies herders reliable access to scarce inputs required for them to attain higher levels of productivity. National research organisations need to establish closer links with those whose problems they are ostensibly meant to be solving, so that they are aware of the many constraints under which livestock producers are operating. This requires a change in the orientation and training of staff so that herder-contact is considered a normal and necessary part of a researcher's duties.

19. A balance needs to be struck between a policy of continued support for all existing research bodies and a policy which regularly questions the value of work being done. Certainly, much research may need a number of years work to be done before judgement can be passed on its output of utilisable results. However, several writers mention that research bodies often continue to attract funds, even when they have a poorly developed programme. Muturi (1981) writing about Kenya, notes that established bodies usually succeed in being funded year after year regardless of the content of their research programme and attributes this to bureaucratic inertia and the ability of researchers to lobby government for financial support.

20. A balance must also be maintained over the spread of research activities to be covered. The evidence supports the view that advances in productivity tend to come from the concentration of money and manpower in particular areas, rather than being spread thinly over many fields. Research systems must try to identify those areas of greatest potential benefit to which to allocate research resources. As discussed at the beginning of this paper, choice among alternative research projects does present peculiar problems, largely due to the uncertainty surrounding the generation by researchers and the adoption by producers of new and profitable technologies. Uncertainty is something all decision makers must live with. Decision-making models can help define those areas of uncertainty and can provide a consistent basis for making choices.

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